1. Bremsstrahlung of Polarized Electron

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1. Introduction

The study of elementary particle and nuclear reactions by high energy photons is one of the main theme of the experiment by the electron accelerator in the range of MeV-GeV. Together with the experiment by the high energy electron, it has played an important role in the clarification of the structure of nuclei. The characteristics of the photon and the electron are well known thanks to the theory of Q.E.D. However it is difficult to obtain the monochromatic high energy photon beam experimentally. The tagging method is one solution to this difficulty.

2. Tagging Method

The tagging method is to make the high energy electron collide with matter of large atomic number like platinum (See Fig.1). By detecting the electron after bremsstrahlung we can specify the emitted photon energy. Since the recoil nucleus is extremely heavy compared with the electron, the conservation law can tell the energy of the emitted photon. In other words, the collision has produced the emission of a photon "tagged" with the recoil electron energy.

3. Motivation

To see the characteristics of the photon, electron-bremsstrahlung was studied for many years under the condition that the spin state of neither incident nor scattered electron is specified. It is not impossible to devise the apparatus which enables us to observe the spin states for both incident and scattered electrons in the near future. Accordingly the theoretical Q.E.D. calculations are presented here for spin specified electrons.

4. Calculation

The spin-energy projection operator is

$$\frac{\not{p}_j + m}{2m} \cdot \frac{1 + \gamma_5 \not{s}_j}{2} .$$

for the initial and the final electrons (j=i,f).

It is found that the calculation becomes considerably simple

if a) the specific gauge choice is made: $\varepsilon^{0}=0$

and b) the electron is transversally polarized:

$$\vec{s}_{J}=\frac{\vec{k}}{|\vec{k}|}\times\frac{\vec{p}_{J}}{|\vec{p}_{J}|}$$

A convenient coordinate system is illustrated in Fig.2.

The differential cross section formula depends only on the change of the electron spin. In other words, as expected, it is determined by whether the spin state of the electron flips or not.

Linearly polarized photon can be obtained if 3 vectors $\vec{p}_{i}$, $\vec{p}_{f}$, $\vec{k}$, lies on a single plane. For a trivial case, a 100% photon polarization is realized in the following table, where ϕ being the angle between the x-axis and the projection of $\vec{p}_{f}$ upon the xy-plane, and Ψ being the angle between the x-axis and the photon polarization.

ϕ	electron spin	Ψ
0	non-flip	$\frac{\pi}{2}$
π	flip	0

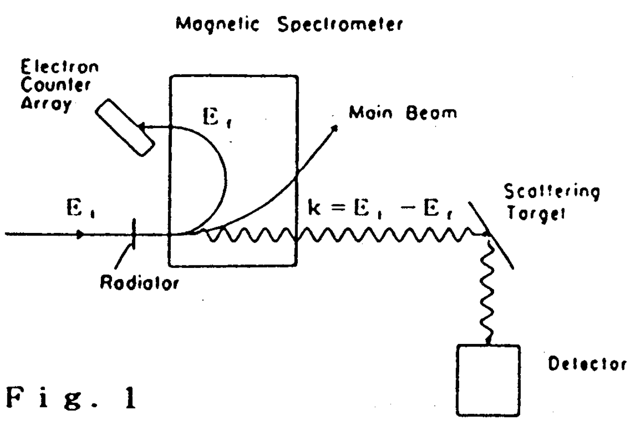

Fig. 1

Fig. 2